

ELEMENT STEWARDSHIP ABSTRACT

for

Elytrigia repens var. *repens* (L.) Desv. ex B.D. Jackson
Synonyms: *Agropyron repens* L. (Beauv.), *Elymus repens* (L.) Gould

Quackgrass

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Edited on: 1/02

THE NATURE CONSERVANCY

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SCIENTIFIC NAME

Elytrigia repens var. *repens* (L.) Desv. ex B.D. Jackson

Synonyms: *Agropyron repens* L. (Beauv.)
Elymus repens (L.) Gould

COMMON NAMES

Quackgrass; couch grass; dog grass; quickgrass; scutch, quitch, twitch

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

Elytrigia repens is an aggressive, cool-season, perennial grass that is native to Eurasia. *E. repens* spreads by both seeds and rhizomes, and its long running rootstocks extend through the soil and send up numerous shoots, forming a loose but tough sod. This grass has a wide distribution and is one of the most difficult weeds to control in cultivated fields.

Rhizomes of *E. repens* can grow 60 cm or more laterally from the main shoot before sending aerial stems, and can grow as deep as 20 cm. Erect stems may reach heights of 30 to 100 cm; decumbent stems are more common and usually grow just 0.5 to 2.0 cm high. Culms are green to whitish in color, and are hollow at anthesis (when anthers and ovules are mature). Leaves are rolled in the bud-shoot. Blades are 3 to 10 mm wide, 8 to 20 cm long, flat but slightly keeled at the base and sharp-pointed. They are green and sometimes slightly glaucous, with the margins and upper surface harsh-scabrous. The leaf sheaths are not compressed, and are not keeled. They are pubescent (or rarely glabrous) with soft, short, erect or retrorse hairs, especially on the lower leaves, with overlapping hyaline margins. (This grass is extremely variable in the degree of hairiness of the blades and sheaths. The hairs are more noticeable on the young leaves in the spring than on those formed later in the season.) Auricles are present in *E. repens*, and are 1 to 3 mm long, slender, terete, clawlike and clasping. Ligules are membranous, 0.5 to 1.0 mm long, obtuse, finely tooth-fringed, ciliolate or entire. Spikes are erect, 8 to 17 cm long, one spikelet per node, the middle internodes 4 to 7 mm long. Rachis joints are usually flat on one side and rounded on the other. Spikelets are 10 to 28 mm long, with 3 to 8 flowers that disarticulate (separate) below the glumes. Glumes are half as long as the spikelet, 5 to 7 veined, lanceolate, acute and have an awn that is 0.5 to 4 mm long. Lemmas are 7 to 10 mm long, 5-veined, glabrous to apically scabrous, tapering to a point or a short, straight awn to 5 to 10 mm long. Anthers are 4.0 to 5.5 mm long. Seeds are lance-shaped, and are 8 to 9 mm long (Gleason and Cronquist 1991; Werner and Rioux 1997).

E. repens can be distinguished from many other grasses by its prominent pale yellow or straw-colored rhizomes with a tough brownish sheath at each joint. The sheathed joints give the rhizomes a scaly appearance. The presence of rhizomes also distinguishes *E. repens* from *Elytrigia spicata*, *E. elongata*, and the closely related *Agropyron cristatum*, all of which are tuft-forming and without rhizomes. *E. repens* may be distinguished from *E. dasystachya* by the longer internodes (7-12+ mm) on *E. dasystachya* spikes, from *E. smithii* by the latter's strongly ridged and furrowed leaf blades, and from *E. pungens* by the latter's pithy culms at anthesis.

PEST WEED STATUS

E. repens is listed as a noxious weed in Canada and in the U.S. states Arizona, Kansas, Michigan, South Dakota, Utah and Wyoming.

STEWARDSHIP SUMMARY

E. repens is an invasive grass found in numerous natural terrestrial grassland communities as well as in agricultural fields in the temperate region of North America. *E. repens* is found primarily in open areas with moderate to high nutrient levels such as agricultural fields, lightly grazed pastures, and waste places. It is early successional, and can invade gardens, yards, crop fields, roadsides, ditches, and other disturbed, moist areas. *E. repens* can also colonize mixed-grass prairies and open woodlands. It tolerates a variety of soil types, including saline conditions, but grows most vigorously in soils of pH 6.5-8.0. *E. repens* will dominate fields for several years after abandonment, but will not tolerate shade. In western North America, *E. repens* invades wet meadows, wetland borders and other low-lying wet areas of grasslands and prairies.

E. repens can form extensive rhizomes that enable it to compete strongly with cultivated crops and native grasses and forbs in prairies and grasslands. It can exclude the regeneration of native woody species where it forms dense stands. It may also hinder the restoration of cropland, rangeland, pasture, and native grasslands. *E. repens* consumes soil moisture and key nutrients (N, P, K) which it removes from the soil during the growing season. As a cool-season grass that can photosynthesize and grow during early spring, *E. repens* can suppress species that photosynthesize and grow during the later, warmer part of the growing season. *E. repens* has also been shown to produce ethylacetate extracts that may be exuded from its shoots and root exudates and which may be allelopathic. Cyclic hydroxamic acids and several other phytotoxins were identified as important allelopathic constituents (Friebe et al. 1995). Such phytotoxins can suppress the growth or reproductive vigor of competing plant species.

Successful control measures for *E. repens* currently include applying herbicides, burning, tilling, and combinations of these three methods. The following herbicides have been used successfully for control: Assure II (quizalofop-P), Fusilade DX (fluazifop-P), Fusion (fluazifop-P + fenoxaprop-P), Poast (sethoxydim), and Select (clethodim) are all selective post-emergence controls for annual and perennial grasses; Accent (nicosulfuron) and Roundup Ultra, Roundup Ultra RT, and Touchdown (glyphosate) are non-selective post-emergence controls. Herbicides are applied in the spring or fall when *E. repens* is 15-20 cm tall and actively growing. A mix of tilling and herbicide application can also be used for good control results. Burning *E. repens* on a biennial schedule for several years has been effective against this species. Control of *E. repens* in croplands is generally accomplished through tillage, in both the spring and fall if possible, which breaks up rhizomes and forces plants to use reserves to regenerate. Field studies indicate that when using tillage alone, at least two years of tilling are needed for complete control. Heavy pasturing or mowing before tilling will also aid in its control.

RANGE

E. repens is a widespread plant and is found on a number of continents and different countries. It is native to Eurasia (temperate Europe and Central Asia: Afghanistan, India, Pakistan), but can be found in parts of South America (Argentina and Chile) and in Australia, New Zealand and Indonesia (Holm et al. 1977). It is widely distributed across North America, and is especially invasive in grass prairie and/or wetlands of western North America. Werner and Rioux (1977) report that *E. repens* is found in every state in the U.S., and in Canada from Newfoundland to

British Columbia. In North America, *E. repens* is reported in National Heritage Program databases from: Alaska, Alberta, Arizona, Arkansas, British Columbia, California, Colorado, Connecticut, Delaware, District of Mackenzie (Northwest Territories), Great Smoky Mountain National Park, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Labrador (Newfoundland), Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Brunswick, New Hampshire, New Jersey, New Mexico, New York, Newfoundland Island (Newfoundland), North Carolina, North Dakota, Nova Scotia, Ohio, Oklahoma, Ontario, Oregon, Pennsylvania, Prince Edward Island, Quebec, Rhode Island, Saskatchewan, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming, and the Yukon Territory.

IMPACTS AND THREATS POSED BY *ELYTRIGIA REPENS*

E. repens can invade disturbed old agricultural fields as well as natural areas such as wet prairies or riparian corridors. *E. repens* is an early successional species, and thus declines in abundance may occur with time without active management, but there have so far not been any reports of decreases in abundance over time with no active management. On TNC preserves, *E. repens* has invaded mesic ecotones (transition areas) between riparian and upland prairies, previously farmed and grazed areas, old home sites, and wet prairie sites with altered hydrologies. Once established, *E. repens* is able to outcompete and exclude native vegetation, resulting in an overall loss of biodiversity.

E. repens forms extensive rhizomes that compete strongly for water and nutrients with cultivated crops and native grasses and forbs in prairies and grasslands. It can also exclude the regeneration of native woody species where it forms dense stands. It may hinder the restoration of cropland, rangeland, pasture, and native grasslands. *E. repens* consumes soil moisture and key nutrients (N, P, K) which it removes from the soil during the growing season. As a cool season grass that can photosynthesize and grow during early spring, *E. repens* can suppress species that photosynthesize and grow during the warmer part of the growing season. *E. repens* has also been shown to produce allelopathic extracts from shoots and root exudates which can suppress the growth or reproductive vigor of competing plant species (Friebe et al. 1995).

HABITAT

E. repens is found primarily in open areas with moderate to high nutrient levels such as agricultural fields, lightly grazed pastures and waste places. It invades gardens, yards, crop fields, roadsides, ditches, and other disturbed moist areas. *E. repens* can also colonize mixed-grass prairies and open woodlands. *E. repens* can grow on a variety of soil types, but prefers medium textured soils. *E. repens* can be found on organic soils and chalk, but cannot tolerate low pH or rock outcrops. *E. repens* grows best in soils of pH 6.5-8.0 (Werner and Rioux 1977). It has also been found in some saline conditions (Holm et al. 1977). *E. repens* will dominate fields for several years after abandonment but cannot tolerate shading. Permanent pastures have not been extensively invaded by *E. repens*, perhaps because of selective feeding by grazers (Werner and Rioux 1977).

ECOLOGY AND BIOLOGY

E. repens is an early seral dominant in disturbed areas. Its ability to maintain high growth rates through cool periods of the year, its dependence on vigorous vegetative reproduction, and its production of allelopathic toxins, all contribute to its high level of competitiveness (Werner and Rioux 1977).

Reproduction

E. repens is wind-pollinated and self-sterile. Seed production is generally 25 to 40 seeds per plant, but can range from 15 up to 400 seeds per culm. Alternating temperatures are required for germination (15° to 25° C diurnal fluctuations). There is no after-ripening period. Seeds may remain dormant in the soil for 2 to 3 years. Seeds can remain viable after passing through the digestive systems of many domestic animals. Seed dispersal mechanisms are unknown (Werner and Rioux 1977).

Vegetative reproduction is more important than reproduction by seed for *E. repens* (Werner and Rioux 1977). Rhizome growth begins from April to May, and aerial shoots elongate into culms. At this time, new rhizomes form near the soil surface. These new rhizomes form apical buds in June and July and will eventually also become aerial shoots. This process continues to mid-fall. Rhizomes are generally dormant in June and activity begins again in the later part of summer to early fall.

E. repens flowers from June through August, depending on local climate conditions. Optimum temperatures for growth are between 20° and 25° C, with no growth occurring below 2° C or above 35° C. Primary rhizome growth begins in late May or early June and then again in September and October. Rhizome growth seems to be favored by low temperatures (10° C) and long days (18 hours). Rhizomes of *E. repens* can survive temperatures as low as -17° C (Stoller 1977).

Root Growth

In experimental studies, rhizomes planted in the fall produced new rhizomes and tillers by the following May. Rhizomes generally occur in the upper 10-15 cm of soil, although in experiments productivity was optimized when rhizomes were planted at depths of 2.5-7.5 cm. Surface shoots can be killed by frosts. Food reserves within the plant appear to fall to minimum during late spring and also during regeneration after tilling (Holm et al. 1977).

ECONOMIC AND OTHER USE

E. repens provides cover for numerous small rodents, birds, and waterfowl in grassland systems (Kirsch and Higgins 1976). Many palatable hybrid crosses of *E. repens* and other species have been developed and planted for livestock. The total crude protein content of *E. repens* is comparable to timothy (*Phleum pratense*) and to alfalfa (*Medicago sativa*) (Werner and Rioux 1977; Marten et al. 1987). *E. repens* has been rated fair in energy value and poor in protein value. The species is effective in stabilizing steep slopes and sandy soil areas. *E. repens* is one of the most effective species for reclaiming nutrients from sewage effluent sprayed on fields (Werner and Rioux 1977). *E. repens* has been used to revegetate mine tailings in Nova Scotia (Warman 1988). It is not a recommended species for such uses in the U.S. (Wasser 1982).

MANAGEMENT

Potential for Restoration of Invaded Sites

Elytrigia repens has unusual reproductive vigor and is moderately adaptable. There is little literature to indicate that in North America, pests or predators appreciably effect *E. repens* populations. The species is widespread and occasionally locally abundant. In natural areas or wildlands, the application of selective herbicides can reduce populations of desirable native grasses. An exception is spring applications of herbicides to control *E. repens* which may have little effect

on warm season bunchgrasses as they are not yet actively growing. The potential for large-scale restoration of wildlands infested with *E. repens* is probably low to moderately low, unless the infested area is tilled, treated with herbicide, and reseeded, or unless large-scale, resource intensive prescribed burn programs, coupled with herbicide and other restoration programs are implemented. If attacked early, wildlands only recently colonized by *E. repens*, have a moderate to high potential for restoration.

Herbicide

The following herbicides have been used successfully for *E. repens* control: Assure II (quizalofop-P), Fusilade DX (fluazifop-P), Fusion (fluazifop-P + fenoxaprop-P), Poast (sethoxydim), and Select (clethodim) are all selective post-emergence controls for annual and perennial grasses; Accent (nicosulfuron) and Roundup Ultra, Roundup Ultra RT, and Touchdown (glyphosate) are non-selective post-emergence controls.

Herbicides are applied in the spring or fall when *E. repens* is 15-20 cm in height and actively growing. Five herbicides (cloproxydim, fluazifop, haloxyfop, quizalofop, and sethoxydim) were compared from 1984 to 1988 for controlling *E. repens* within different crop competition and tillage conditions. Crop competition usually augmented *E. repens* control with the herbicides. Without crop competition, haloxyfop and quizalofop were more effective than the other herbicides in conventional tillage. In a conventional tillage situation, the herbicides ranked in order of decreasing effectiveness as follows: quizalofop, haloxyfop, fluazifop, cloproxydim, and finally sethoxydim. In a zero-tillage situation, none of the herbicides reduced *E. repens* significantly (Harker and O'Sullivan 1993).

Gary Haase at TNC's Kitty Todd Preserve in Ohio reported that glyphosate (tradename RoundUp) applied at 5% provides excellent control. He also reports that the herbicide fluazifop-p (tradename Fusilade) provides good control when applied at a rate of 1 quart Fusilade + 2 quarts crop oil (adjuvant) to 50 gallons of water. He adds that Fusilade is easier to use than Roundup, because it kills only grasses, and if sprayed early enough, it seems not to affect warm-season grasses (Randall and Meyers-Rice, unpubl.). The use of herbicides should be followed with plantings of species that are strongly competitive with *E. repens*.

Darren Borgias of TNC's Ewauna Flat Preserve in Oregon, however, reports that the herbicides glyphosate, sethoxydim, and fluazifop, had little to no effect on controlling *E. repens*. He adds that his application of these herbicides may have been too late in the season to be effective. He suggests perhaps trying these herbicides earlier in the season, during active growth.

Grasses and other forage crops will not eradicate *E. repens*, but when it is in competition with these crops, *E. repens* roots grow near the surface. A mix of tilling and herbicide can then be used. First thoroughly disc the infested area to the lowermost root depth of *E. repens* in early October but before a hard frost, and then use an herbicide such as Roundup for best control (Crop-Net Website).

Prescribed Burning

Gary Haase (TNC-Ohio) reports that burning was not effective in controlling the spread of *E. repens*. Burning on a repeated or biennial schedule for several years, however, has been effective in eradicating *E. repens* in some cases. Species that grow early in the season, including cool-season grasses such as *E. repens*, should suffer greater damage from early spring burns than species that grow in the mid-growing season (e.g., warm-season grasses) (Howe 1995). Further, since cool-season grasses can grow in the fall following summer dormancy, fall burns might also help reduce undesirable cool-season grasses (Risser et al. 1981). In experimental treatments that

compare the results of early spring and growing season burns in Wisconsin, *E. repens* declined most significantly following repeated early spring (March and April) burns (Howe 1995). A May burn in oak savannas in Wisconsin significantly reduced *E. repens* biomass and cover and halted flowering. Similar reductions in biomass and cover have been shown for other areas. In some cases *E. repens* cover increased following fire. Five annual late April to early May burns in Minnesota resulted in a decrease in *E. repens* height, but in an increase in cover. Plant vigor was reduced and flowering stopped, but *E. repens* continued to spread to adjacent areas. May and June burns on North Dakota grasslands reduced *E. repens* in the first post-burn season, but it recovered to almost pre-burn levels by the second post-burn season (*Fire Effects Information System* [Online] 1996). Following a late June fire, *E. repens* showed a slight increase in cover, height, shoot density, production, and flowering. Wisconsin grassland fires in March caused an increase in seed production by July and August (Halvorsen and Anderson 1983).

Environmental/cultural control

Control of *E. repens* in croplands is generally accomplished through tillage, which breaks up rhizomes and forces plants to use reserves to regenerate. Field studies indicate that two years minimum, are needed for complete control using tillage alone (Limieux et al.1993). For control in field-size infestations, tilling should be done in the fall using a plow, disc or cultivator (taking care to not spread rhizome parts from field to field). In the spring, tilling should be repeated when topgrowth approaches 5 cm. In moist years, a cultivator followed by a cable weeder or oscillating harrow can be used to lay the rootstalks on the surface. If the year is too wet for tillage, infestations should be mowed or grazed to prevent seed production. Heavy pasturing or mowing before tilling will aid in eradication.

In Oregon, altered hydrology may have facilitated the invasion of new habitats by *E. repens*. Darren Borgias (TNC-Oregon) suggests that perhaps by restoring natural flow and historical hydrological regimes, that *E. repens* invasion may be controlled.

Management Programs

E. repens has received a great deal of attention for control in croplands, but little published material exists on the control of this weed in wildlands. There is also a large body of work (*Fire Effects Information System* [Online] (1996)) on prairie and grassland management in which fire management is used to restore or maintain native grasslands. However, such management has generally been directed toward reducing a number of invasive species, and not just *E. repens*.

ELYTRIGIA REPENS MANAGEMENT ON TNC PRESERVES

In Idaho's Silver Creek Preserve, *E. repens* has infested over 100 acres. It has invaded old agricultural fields, and is invading the land between riparian and upland habitats. As of the 1998-1999 TNC Weed Survey, no active management has been done to control the spread of *E. repens* at the Silver Creek Preserve.

In Oregon's Ewauna Flat Preserve, Darren Borgias (TNC-SW Oregon Steward) noticed that an altered hydrology regime may have facilitated the invasion of new habitats by *E. repens*. Darren reported that cutting and burning slows the growth of *E. repens* in the following year, and that applied herbicides (Roundup, Sethoxydim, and Fluazifop) had no effect on controlling this weed. The timing of herbicide application may have been too late to be beneficial.

Gary Haase, of Ohio's Kitty Todd Preserve, reported that burning was not effective in controlling the spread of *E. repens*, but the use of herbicides was extremely effective. Roundup at 5% was

successful at killing *E. repens*, and Fusilade (0.5%) was also very effective, as well as easy to use since it is a grass-specific herbicide. He used 1 quart of Fusilade + 2 quarts of crop oil + 50 gallons of water, and reported that it was about 80% effective at controlling *E. repens*. He added that herbicide was the only viable option for controlling *E. repens*, and that if spraying occurs early enough in the growing season, native warm-season grasses will be left unaffected.

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MONITORING

As *E. repens* is an early successional species, declines in abundance may occur in time without active management. Where management actions are being measured, monitoring of both the target species or species components of the target community should be undertaken along with monitoring of *E. repens*. In natural areas management, monitoring programs will likely measure both changes in abundance of *E. repens* with changes in abundance of species or changes in community attributes that are the targets of management. Such programs should have explicit objectives that can be measured and that are meaningful from both a biological and management standpoint. These objectives may vary depending on the abundance of *E. repens* and other invasives. For instance, the objective of managing a grassland with 40% cover of *E. repens* may be to reduce cover to 20%, while the objective for an area with cover of 10% may be to prevent an increase of more than 10% of total cover (20% total). Monitoring the status of other conservation targets such as invertebrates dependent on specific food sources may be more important than tracking invasives. In general, the objectives of monitoring should track those of management.

In terms of effort (number of plots established and monitored), transects or long, linear plots laid lengthwise across known environmental gradients are usually more effective in providing sufficient statistical power to determine change than square or broadly rectangular or otherwise regularly shaped quadrats. Analyses of plant species composition and abundance can be simplified by (1) collecting data on abundance of dominant species; (2) collecting data on all species and pooling data on less abundant species; and (3) pooling data on species by placing them in guilds (invasive grasses, invasive legumes, native grasses, etc.).

While generally a research technique, measuring change or lack thereof in control (unmanaged) areas can be an effective way of assuring that changes are actually the result of management and

not from other factors. Since *E. repens* is an early successional species, declines in abundance may occur with time without management, as mentioned previously, although there have been no documented cases of naturally occurring declines in abundance.

The development of a monitoring program is highly individualized to each situation. If you need assistance or have questions regarding how to start or maintain a monitoring program, contact John Randall, TNC's Weed Specialist at (530) 754-8890 or jarandall@ucdavis.edu, or Bob Unnasch, TNC's Director of Ecological Monitoring at (208) 343-8826 or bunnasch@tnc.org.

RESEARCH

More specific research is needed on the impacts of *E. repens* on native grassland and prairie plants and animals and on alternative methods of control of *E. repens*, such as mowing and fire management, especially where those techniques are used for the management of rare species and unique natural communities. Control efforts followed by the introduction of field crops have been effective; research on similarly following control efforts with native species planting is needed. Further research is also needed on the effects of herbicides on native species that are conservation targets.

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